Docket No.: 1509-487 **PATENT**

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

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U.S. Patent Application No.	:	Group Art Unit:
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Filed: herewith	:	Examiner:

For: ATTENTION DETECTION

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Commissioner for Patents
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Dear Sir:

In accordance with the provisions of 35 U.S.C. 119, Applicant hereby claims, in the present application, the priority of GB Patent Application No. 0308739.2, filed April 15, 2003. The certified copy is submitted herewith.

Respectfully submitted,

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Date: April 13, 2004

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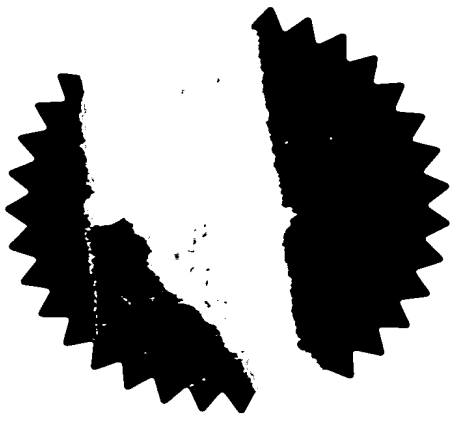

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1. Your reference — 200207945-1 GB

2. Patent application number
(The Patent Office will fill in this part) — 0308739.2

15 APR 2003

3. Full name, address and postcode of the or of each applicant *(underline all surnames)*

Hewlett-Packard Development Company, L.P.
20555 S.H. 249
Houston, TX 77070
USA

Patents ADP number *(if you know it)* 8557886001

If the applicant is a corporate body, give the country/state of its incorporation — Texas - USA

4. Title of the invention — Attention Detection

5. Name of your agent *(if you have one)*

"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*

Bruce G R Jones
Hewlett-Packard Ltd, IP Section
Filton Road, Stoke Gifford
BRISTOL BS34 8QZ

Patents ADP number *(if you know it)* 8072258001

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Signature Date

Bruce Graeme Roland Jones 11 April 03

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ATTENTION DETECTION

Field of the Invention

The present invention relates to detection of an attention state of at least one person. and particularly, although not exclusively, to a method and apparatus for autonomously collecting images.

Background to the Invention

Known camera technology, including cameras of the conventional film type, and digital cameras, consumer type cameras and professional type cameras, are based upon a usage model which requires a human photographer to point the camera at a field of view containing a subject of which a picture, image or video is to be captured, and activating a trigger button causing the camera to capture a still image, or in the case of a video camera, a moving picture scene.

Known still image cameras and video/film cameras for consumer and professional use are effectively products which are used by a photographer to capture an image or moving sequence of a scene, where the photographer consciously selects the scene, sets up the camera positioning for a particular view, and activates capture of an image or sequence of images as a photographer controlled activity.

In some cases, automatic triggers are provided on a timer device, whereby the photographer can set a camera up pointing at a scene, activate a time delay trigger, giving the photographer time to enter the scene, and then the camera automatically takes a picture or sequence once the pre-determined time limit has elapsed, allowing the photographer to appear in her own images.

There are also known prior art surveillance camera systems, which automatically capture still images or video sequences. Such cameras are used for security purposes in commercial premises such as factories and offices, as well as in domestic environments for security. These known cameras capture images or sequences of images in response to sensor activated events, such as an infra-red sensor being triggered, a movement sensor, or a circuit breaker sensor, for example a sensor which is activated when a door or window is opened. In general, this type of camera is wall mounted or mounted on posts, and pre-arranged to take a picture of a pre-determined scene. The cameras are not mobile and provide a permanent security monitoring installation.

In some cases, surveillance cameras are directable remotely from a central console unit, so that they can pan across a field of view and focus in and out of that field of view by remote control, the cameras being moved and controlled by servomotors.

There are also known surveillance cameras for other uses, for example traffic monitoring, and speed detection, which are triggered by motion sensors which detect vehicles moving within pre-set speed limits. This type of camera is conventionally installed in a permanent installation, pointing at a pre-determined scene.

The known surveillance cameras and traffic monitoring cameras provide fixed installations which operate without a human photographer, but are limited in their fields of view.

More recently, compact cameras have been installed in personal communications devices, such as mobile phones. Pictures of individuals can be taken using hand held devices, and sent as messages over a wireless communications network to personal handsets of other users. With these hand held devices, the basic mode of usage requires a person to act as a photographer, pointing the device at a field of view, for example directing the

device at their own face to take a picture of themselves, and activating capture of an image by triggering a switch.

The concept of a user wearable camera device receiving attention clues from a host wearer and capturing images is known. For example in *Summarizing Wearable Video', K. Aizawa, K. I. Ishijima, M. Shiina,* IEEE, International conference on image processing, III:398-401, Thessaloniki, Greece, 2001, there is disclosed a system which receives sensor inputs from a host wearer, and which attempts to understand those sensor inputs in order to determine when to perform capture of an image.

Other known work which analyses a host wearers attention from a self perspective point of view includes the following:

J Healey and R.W. Picard, "StartleCam: A Cybernetic Wearable Camera", *In Proceedings of the International Symposium on Wearable Computers, pages 42-49, 1998.*

A.Lockerd, F. Mueller, "LAFcam – Leveraging Affective Feedback Camcorder", ACM CHI, 2002.

Y Nakamura, J.Ohde, Y. Otha, "Structuring personal activity records based on attention: Analysing vidoes from a head-mounted camera", in *International Conference Pattern Recognition,* Barcelona, September 2000.

Known usage models and systems for detecting a persons attention focus on analyzing the actions and behavior of a person from the perspective of that person, that is analyzing parameters which are local to a person and in an immediate vicinity of a person from a position at the host person.

A further body of known work is concerned with observing a person from a position external of that person, that is from an external perspective. This known body of work includes the following items:

A.Pentland, "*Looking at People: Sensing for Ubiquitous and Wearable Computing*, IEEE Trans. Pattern Analysis and Machine Intelligence, IEEE CS Press, Los Alamitos, Calif., Jan. 2000, pp. 107-118.

M.Trivedi, I.Mikic, S. Bhonsle, "Active Camera Networks and Sematic Event Databases for Intelligent Environments", IEEE Workshop on Human Modeling, Analysis and Synthesis, June 2000.

A.Pentland, T.Choudhury. "Face Recognition for Smart Environments", *IEEE Computer*, vol. 33, no. 2, February 2000, pp. 50-55.

D.Gavrila, "The Visual Analysis of Human Movement: A Survey", *Computer Vision and Image Understanding,* vol. 73, no.1, January 1999, pp. 82-98.

V.Pavlovic, R. Sharma, T. Huang, "Visual Interpretation of Hand Gestures for Human-Computer Interaction: A Review". IEEE Trans. PAMI, vol. 19, no. 7, July 1997, pp. 677-695.

R. Stiefelhagen, J.Yang, A.Waibel, "Estimating focus of attention based on gaze and sound", *Proceedings of the Workshop on Perceptive User Interfaces,* 2001.

R.Vertegaal, R.Slagter, G.van der Veer, A.Nijholt, "Why conversational agents should catch the eye", In *Summary of ACM CHI Conference on Human Factors in Computing,,* The Hague, 2000.

Some known devices such as disclosed in the above bodies of work could be referred to as 's', which observe a person from a position external of that person.

Summary of the Invention

A first aspect of the present invention relates to autonomous image capture, and the detection of situations of interest to users of cameras, in order to trigger automated image capture without conscious human user activation of a camera device. Embodiment of the invention provide an autonomous wearable camera system which is able to capture images of moments by inferring situations of interest to persons.

Further embodiments may provide for the use of an agent device which is able to interpret 'attention clues' given out by human persons, the attention clues being used to activate one or more image capture devices for capture of images when the attention clues are detected. The device may be implemented as one or more firmware devices, or as a software agent. Specific implementations herein aim to implement a system for autonomously determining a situational saliency based upon the attention clues, in order to trigger capture of one or a set of images in that situation.

In one embodiment, a user carries a wearable camera. The agent device may be situated on the wearer's body. In other embodiments, the device may be situated elsewhere, or the agent device may be distributed.

Where the agent device is worn by a person carrying a camera, the agent device may be capable of adopting a 'self-perspective' mode, in which the agent device observes situations from the perspective of a host person who is wearing an image capture device. In this mode, the agent device may receive attention clues in the form of sensor signals of parameters of the wearer, for example skin conductivity, body movement, or voice utterances made by the host wearer. In

the self-perspective mode, since the agent device is in close proximity to a person. In order to capture images in the self perspective mode, the agent device requires input from sensors strategically placed on the host wearer, including limb positioning sensors, eye trackers, and the like.

The agent device combines information collected about the host wearer in the self perspective mode with externally received information collected about the same host wearer or similar or complimentary device which has collected information in an 'external' perspective mode. The agent device determines from the combination of self perspective attention clues and external perspective attention clues whether the host wearer is experiencing a situation in which their attention is raised to a level where recording of an environmental situation in which the user finds themselves would be of interest to that user.

In an 'external' perspective mode, an agent device may analyze a another person's body language and attention clues from a perspective external to the person, that is, as an entity remote from the person and observing the person. The agent device may be physically positioned away from that other person, and may observe that other person. In this mode, the agent device may detect externally detectable attention clues given out by the other person, for example limb movements, pointing of a finger, movement of eye look direction, rapid re-orientation of a head of the person, aspects of the other persons body posture, and like attention indicating body language signals.

According to one aspect of the present invention, there is provided an attention detection system comprising:

a portable attention detection module capable of receiving attention clues of a host person, said attention clues generated from a self perspective of said host person, and receiving attention clues of said host person generated from an observer perspective;

at least one sensor device capable of generating signals relating to said attention clue signals of said self perspective; and

at least one sensor device capable of generating signals relating to said attention clue signals of said observer perspective.;

wherein said attention detection module is capable of determining a situation of raised attention of said host wearer from said self perspective attention clues, and said received observer perspective attention clues.

Other aspects of the invention are as recited in the claims herein.

Brief Description of the Drawings

For a better understanding of the invention and to show how the same may be carried into effect, there will now be described by way of example only, specific embodiments, methods and processes according to the present invention with reference to the accompanying drawings in which:

Fig. 1 illustrates schematically usage of one embodiment of a personal image capture device worn by a host person ;

Fig. 2 illustrates schematically operation of one implementation of an image capture system comprising a plurality of image capture devices, each worn by a corresponding host person

Fig. 3 illustrates schematically logical entities comprising a specific implementation of an image capture system

Fig. 4 illustrates schematically information processing stages for processing information in the image capture system of Fig. 3;

Fig. 5 illustrates schematically components of one implementation of a people observer device;

Fig. 6 illustrates schematically components of one implementation of an attention detection module;

Fig. 7 illustrates schematically components of one implementation of an image capture device;

Fig. 8 illustrates schematically an example of various sensor types according to the specific implementation of the image capture system;

Fig. 9 illustrates schematically a specific embodiment of an image capture system comprising three portable devices, each comprising an image capture device, a people observer device and an attention detection module;

Fig. 10 illustrates schematically an analysis of a two dimensional captured digital image of a person according to a specific method

Fig. 11 illustrates schematically a specific embodiment of an analyzer component of an attention detection module

Fig. 12 illustrates schematically sensor inputs to a people observation device in a self perspective mode of operation of an image capture system; and

Fig. 13 illustrates schematically a specific method of interaction between first and second attention detection modules each operating in a self-perspective mode and in an observer mode.

Detailed Description of a Specific Mode for Carrying Out the Invention

There will now be described by way of example a specific mode contemplated by the inventors for carrying out the invention. In the following description numerous specific details are set forth in order to provide a thorough understanding. It will be apparent however, to one skilled in the art, that the present invention may be practised without limitation to these specific details. In other instances, well known methods and structures have not been described in detail so as not to unnecessarily obscure the description.

Referring to Fig. 1 herein, there is schematically illustrated a person carrying a portable image capture device capable of capturing images of a scene in a field of view of the image capture device. Typically, the image capture device may comprise a digital camera having a charge coupled device (CCD) array.

The image capture device may be activated remotely by a wireless signal from a remote transmitter, in order to capture an image. The image capture device may also be activated by signals generated by local sensors worn on the persons body.

The portable image capture device comprises an attention detection module (ADM) which receives attention information indicating an attention level of the host wearer from a device external of the host wearer.

The attention detection module communicates with at least one external people-observing device, such that the attention detection module can combine self perspective information received directly from the host wearers body, with observer perspective information concerning the host wearer, which is received from the external people-observing device, in order to determine a condition under which the host wearer is experiencing a situation in which the wearer's attention is raised, and in response to such a condition, for activating capture of a

still image, image sequence, or capture of another like media, from a host perspective.

Whilst an image capture device is described herein, with reference to the first embodiment of Fig.1, attention clues of the host wearer can be used for capturing any other media type, for example including but not limited to audio data, still images, video sequences, pressure or temperature changes, or other changes in environmental parameters which can be experienced from the perspective of the host person.

Referring to Fig. 2 herein there is schematically illustrated a situation of use of an image capture system in which 2 individual users are in proximity to each other, each user carrying a portable image capture device, which in this case incorporates an agent device capable of observing a host person wearing the image capture device, as well as observing other persons. The users are close enough such that an image capture device of a first user can capture a still or moving image of a second user, and are in close enough proximity that first and second image capture devices can communicate with each other over a wireless link, for sending and receiving activation signals for activating capture of an image.

In this situation, the persons interact with each other using body language, such as waving, smiling, laughing, gesticulating, and adopting postures. Body language signals are collected through a system of sensors, which input attention signals into a (POD) comprising the agent device. The converts the attention signals into attention clue data. The attention clue data is processed to determine whether there is a situation in which the body language of the persons is indicating that there is enough interest to the persons, that capture of an image may be appropriate. If the saliency of the situation high enough that capture of an image is appropriate, then one or more image capture signals is generated for activating one or more image capture devices to capture one or more images.

In the situation illustrated in Fig. 2 herein, a range of attention clues are collected, both from a self perspective, and from an external observer perspective, concerning the body language and behavior of the first host user. Self perspective attention clues, for example body movement, breathing rate, heart rate, blood pressure, skin resitivity, direction of motion and the like may be measured by sensors worn by the host wearer. However other attention clues which are available from an observer perspective, but which are difficult to assess from a self perspective are provided by the which is external of the host wearer of the image capture device. Such attention clue information may include parameters such as for example overall body posture, eye gaze direction, facial expression, overall body motion, or limb motion such as waving, pointing location of the host wearer with respective to other objects in an environment or the like which are best observed from a position external of a person.

The attention detection module carried or worn by the host wearer assimilates both sets of attention information, that is, the self perspective and observer perspective attention clues, to determine a state of attention of the host wearer of the attention detection module.

Referring to Fig. 3 herein, there is shown schematically in a general case logical entities present in an image capture system according to a specific implementation of the present invention. The logical entities comprise a plurality of s 300, 301 ; a plurality of attention detection modules 302, 303; a plurality of image capture devices 304, 305; and a plurality of sensors 306, 307.

In this example shown, each user carries a 300, 301; an attention detection module 302, 303; and an image capture device 304 to 305. However, in the general case, the location of the s, and attention detection modules need not be restricted to being worn by human persons. Similarly, although in many implementations sensors are worn by individual persons, in the general case, sensors can be provided at remote positions, for example mounted on walls or posts, for observing persons remotely.

Each comprises a set of algorithms for detecting attention clues exhibited by a host wearer of the . Each receives signals from one or a plurality of sensors 306, 307 respectively.

Each attention detection module comprises one or more algorithms for analyzing attention clues relating to the host wearer of a particular image capture device, and for analyzing attention clues received externally from other s relating to attention clues exhibited by one or more other host persons.

Referring to Fig. 4 herein, there is illustrated schematically information processing stages shown in the image capture system of Fig. 3 herein.

Body language information 400 exhibited by the persons in proximity of the s is detected by one or more sensors. The sensors generate sensor signals, which comprise signals, sensing various parameters, for example movement, sound, 2-dimensional images and the like. The sensor signals are input into an attention detection module, which analyses the sensor signals to determine a set of attention clues collected from a self perspective. Attention clues comprise data which represents the information that the attention of the host wearer person has been raised. The attention clues are input into an attention detection module. The attention detection module also receives attention clues 403 generated by an external people-observing device relating to the host wearer person. The attention detection module processes the attention clue data to determine whether an attention level of the host wearer person, is at a level where an image of a situation is likely to be of interest, and worth capturing. If so, the attention detection module generates a set of camera trigger signals 404 for activating capture of images by one or more image capture devices. This results in a set of images 405 of a situation which has occurred which has raised an attention level of one or more persons to a level such that it triggers capture of the image.

Referring to Fig. 5 herein there is shown schematically components of a people-observing device 500. The people-observing device comprises a transponder 501 and an antenna 502; a controller 503 for controlling the device; optionally, an image capture device 504 for capturing images of scenes; an image memory 505 for storing image data of images captured by the image capture device; a proximity sensor 506 for sensing when the people-observing device is within range of one or more other people-observing devices and/or one or more attention detection modules; a host sensor interface 507 for receiving signals from a plurality of host sensors which may be worn by a host person wearing the people-observing device; a set of connectors 508 which can be used optionally for directly connecting one or more sensors to the host sensor interface; and an attention detector 509 for detecting attention clues of a host wearer, and/or one or more other persons.

First and second people-observing devices may be provided with beacons to locate and detect each other, for enabling an exchange of information between people-observing devices. A said people-observing device may be configured for recognizing at least one other people-observing device to form a group of people-observing devices which recognize each other. The people-observing device may be configurable to communicate or not communicate with at least one other people-observing device, based on an analysis of contextual information relating to a host person, or an observed person. Such contextual information may comprise a location of a person, a time of day , a local environment in which the person finds themselves, or like contextual information.

The people-observing device may be configurable to communicate or not communicate with at least one other people-observing device based on an analysis of a type of attention clue detected, for example, whether a short casual glance is exchanged with a person, or whether a longer glance is exchanged with a person.

The people-observing device may also be configurable for being set to communicate or not communicate with at least one said attention detection module depending upon a type of attention clue detected, for example a particular facial expression, a body posture type, a head direction or an eye gaze direction or an arm gesture.

Referring to Fig. 6 herein, there is shown schematically components of an attention detection module 600. The module comprises a transponder 601 and an antenna 602 for communicating with one or more other attention detection modules, and one or more people-observing devices; a controller 603; a host people-observing device interface 604 for interfacing with a people-observing device worn by a same host person as may be wearing the attention detection module; a self perspective attention analyzer 605 for analyzing attention clues of a host wearer; an observer perspective analyzer 606 for analyzing attention clues observed of persons other than the host wearer person; and an internal data bus 607 connecting the above elements. It will be appreciated by persons skilled in the art that power supplies, casings, and like known components are also provided in order to create a practical manufactured unit.

The attention analyzers comprise various components for detecting when the attention of a person or persons is raised. These components include a component for detecting a facial expression of one or more persons, a component for detecting an eye direction of a person, a component for detecting an attitude of movement of one or more persons, a component for detecting a body posture of one or more persons, and a component for detecting a context of an environment containing one or more persons.

In the foregoing embodiments and implementations, an attention detection module has been shown worn personally by a host wearer. The attention detection module is personal to a host wearer, in the sense that an attention detection module monitors a host wearer and receives attention clues which have been collected from the perspective of the host wearer, and attention clues

concerning that host wearer which have been collected from an observer perspective from a position external of that host wearer. The physical location of the attention detection module is not restricted to being worn or personally carried by a host wearer, but may itself be remote from the host wearer. However, an attention detection module is assigned to a host wearer for detecting an attention status of that host wearer, and therefore in that sense is personal to that host wearer. However in a preferred embodiment, an attention detection module would be carried or worn by a host wearer.

Referring to Fig. 7 herein, there is illustrated schematically components of an image capture device 700. The image capture device comprises a transponder 701 and an associated antenna 702; a set of image capture optics and sensors 703, for example a charged coupled device (CCD) array; a controller 704; an image memory 705 for storing image data; an internal bus 706; and a people-observing device interface 707, for connecting to a local people-observing device, where this is worn by a same host user as the image capture device.

The image capture device is capable of receiving trigger signals from one or more attention detection modules, over a wireless link using the antenna 702 and transponder 701. Activation of the image capture device causes the device to capture an image or image sequence and store this in the image memory 705 under control of the controller 704.

The image capture device is also capable of acting as a monitoring sensor for collecting 2-dimensional images of one or more persons, for input into a people-observing device. In the embodiments shown, the capture image data may be transmitted over the wireless link via the antenna 702 and transponder 701 to a remote people-observing device.

It will be appreciated by the person skilled in the art that although a people-observing device 500, attention detection module 600, and an image capture device 700 are illustrated in Figs. 5 to 7 herein as stand alone discrete entities,

each capable of communicating with each other via a wireless link, these three components may be integrated into a single physical device, or combinations of the components may be integrated into one or more physical devices. Where the components are integrated into a single physical device, they may be worn by a single host person.

In an embodiment where the people-observing device and the image capture device are both worn by a wearer, the image data may be made available directly to the people-observing device via an internal bus or an interface.

Referring to Fig. 8 herein, there is illustrated schematically a set of personal sensors worn by a host person for detecting body language exhibited by the host person. Sensor types can include the following:

Motion sensors for detecting the motion of a limb of a person, for example raising of an arm, rotation of a head or the like. A motion sensor may be implemented in the form of a wrist strap 800 containing a small gyroscope, for example a laser gyroscope, or a fibre optic gyroscope. Alternatively, a motion sensor may be implemented in the form of a jewelry item, for example an earring or ear stud 801 for detecting rapid head rotation. A motion sensor may include an accelerometer. Motion sensors may also be worn or attached to other clothing items, for example included in the sole of a shoe or other footwear.

Temperature sensors: Temperature sensors for measuring skin temperature or other body temperature may be implemented as jewelry items which are worn in contact with the skin, for example as a wrist watch or bracelet. Temperature sensors may be included within clothing worn next to a person's skin, for example as thin conductive strips woven into a material which a person can wear.

Voice detectors and sound detectors. A sound detector may be implemented within a people-observing device itself, or may be worn externally as a headset 802 having a microphone positioned near a person's mouth.

Two-dimensional image sensors: An image capture device itself 803 may be used as a sensor. For example the image capture device may capture an image of a person other then the host person wearing the image capture device, or a general scene external to a host person wearing the image capture device.

There will now be described in further detail, various elements of the image capture system. In some cases, the elements described are specific to a particular implementation of the image capture system, and it will be appreciated by persons skilled in the art that variations in the precise implementation of the various elements described may be made.

Referring to Fig. 9 herein, there is shown schematically an implementation of an image capture system comprising 3 portable camera units 900 to 902, each said camera unit comprising an image capture device; a people-observing device; and an attention detection module, engineered into a single casing which is portable and battery powered, and can be worn, carried or held by a person.

There will now be described various aspects of operation of the image capture system described with reference to Figs. 1 – 9 herein.

Referring to Fig. 10 herein, there is illustrated schematically a still image captured by an image capture device, from which an attention clue can be abstracted. The image taken is of a person having a facial expression, e.g. a smile or laugh. The image capture device captures a 2-dimensional image, which is processed by an attention detection module.

The two dimensional image may be converted into a bitmap, and algorithms applied to the bitmap, for edge detection to detect edges of features, and

algorithms for detection of human faces or human outlines. These algorithms may be resident in either a people-observing device or an attention detection module. Facial expressions may be detected, by detecting edges, and then comparing a set of detected edges, or alternatively points on those edges, with a predetermined library of edges or points which corresponds to a persons smiling or laughing facial expression.

The attention detection module comprises a self perspective attention analyzer and an observer perspective attention analyzer. Referring to Fig. 11 herein, the self perspective and observer perspective attention analyzers may share attention detection components, such as common image processing components for processing two dimensional images. The image processing components include an edge detection algorithm 1101 for detecting edges within a two dimensional image; a human outline detector component 1102 for detecting a human outline from a two dimensional image frame, or a sequence of two dimensional image frames; a facial expression analysis component 1103 for detecting various facial expressions, for example dilated pupils, a smile, a surprise expression and like expressions which indicate that the attention of a human has been captivated by a subject; a motion analyzer component 1104 for analyzing motion from a sequence of two dimensional images; and a posture analyzer component 1105 for analyzing a posture of a human being from a two dimensional image or a sequence of two dimensional images.

Each of the components may be implemented by a general purpose computer, under control of an application, or alternatively, may be implemented in firmware, for example in an application specific integrated circuit, in which case the analyzer component may be manufactured to be small enough to be portable and worn upon a host human.

The attention detection module, in determining whether a persons state of attention has been raised sufficiently to activate capture of data on behalf of that person, takes into account attention clues collected from a self perspective, and

attention clues detected from an observer perspective. However, the attention detection module does not necessarily need to give each type of attention clue an equal weighting, in determining whether a host persons attention has been raised. Depending upon the type of attention clue, and other factors including for example an environment in which the host person finds themselves, a disproportional higher amount of weighting may be given either to self perspective attention clues, or observer perspective attention clues.

Referring to Fig. 12 herein, there are illustrated schematically a set of sensors feeding instructions to a people observation device. The sensors may be incorporated integrally with the people observation device, or may be provided externally to the people observation device, and send signals to the people observation device. Sensor types include the following:

temperature sensors for sensing skin temperature of a host person carrying the sensor;

an image capture device, for example a charge couple delay device for capturing images in a self perspective mode of a scene, which may include other people;

a set of biosensors, including a heart rate monitor, a perspiration monitoring sensor, a skin conductivity monitoring sensor;

one or a plurality of motion sensors for sensing parameters such as head rotation, arm movement and leg movement;

one or more audio sensors, for example a microphone.

Each of the sensors feed sensor signals to the people observation device. The people observation device processes the sensor signals, into a form into which they can be analyzed by the attention detection module.

The agent device of the image capture system may be operated in various modes of operation including a self perspective mode, or an observer perspective mode. Each of these modes of operation require a different configuration of the components of the system.

The modes function as follows:

In the self perspective mode of operation, attention of a person is activated from the perspective of a host person carrying an image capture device. The host person may become interested in various aspects of their environment. For example, the person may look at an airoplane in the sky, or may turn around to look at a passing person, or may have their attention attracted by an event, for example a load bang, a car crash or some other distracting event in the persons immediate surroundings. Sensors carried by the person monitor the host person's body language. A people-observing device carried by the host person receives signals from the sensors, and generates attention clue signals. The attention clue signals comprise signals from the sensors at various levels of data processing. For example in the case of a two dimensional image data, this may be processed very little, and may undergo almost no processing of the information content of the signal prior to being forwarded to the attention detection module. In the case of an audio signal, the information in the audio signal may be processed to before being presented to the attention detection module. For example the audio signal may be filtered such that only audio signals above predetermined amplitude are passed to the attention detection module, with normal background environment signals at a relatively low level of loudness being filtered out by the people-observing device. The level of information processing to be applied to the sensor signals before passing those signals on to the attention detection module is an implementation specific design parameter which may be varied from system to system.

In the self perspective mode, the attention detection module receives signals from the host wearer, which represent the body language of the host person, to which the attention detection module is assigned to monitor, that is, represents information describing an attention level from the perspective of the host person. These self perspective attention clues are analyzed, and as a result of the analysis, an image capture signal for activating an image capture device worn by the host user is generated when the analyzer determines that the attention of the host user is raised to such a level that there is a significant or interesting event in the host users immediate environment, of which an image should be captured.

In an observer perspective mode, one or more people-observing devices are used to observe persons other than a host person wearing the people-observing device. For example where first and second host persons each carry first and second corresponding respective people-observing devices, and each carry a corresponding attention detection module, a first people-observing device of a first host person may observe the second person. Observation can take one of the forms mentioned above, for example continuous monitoring of a moving captured image of the second person. Upon detecting a significant sensed parameter, the first people-observing device generates an attention clue signal which may be processed by the first attention detection module carried by the host person. Attention clues relate to the second person, rather than the first host person.

The first attention detection module, having determined that the second person's level of attention is raised to a high level may send signals to the first image capture device worn by the first person, and/or an activation signal to the second image capture device worn by the second person for either one or both of those devices to capture a corresponding respective image.

Conversely, the second people-observing device worn by the second person monitors the attention of the first person or any other third person in the

environment. The second people-observing device, having observed behavior of the first person, may generate attention clues which it sends to the second attention detection module. The second attention detection module analyses those attention clues and where appropriate, generates one or more trigger signals and sends those to the second image capture device and/or first image capture device to trigger capturing of an image or image sequence by the second and/or first image capture devices.

Referring to Figure 13 herein, there is illustrated schematically interaction between first and second attention detection modules 1300, 1301 respectively where first attention detection module 1300 is worn by a first host person, and second attention detection module 1301 is worn by a second host person.

First attention detection module performs attention detection processes 1, 2, 4, 10 based upon a plurality of attention clue signals, 1, 2, 4, 10 respectively. The first attention detection module receives data from the second attention detection module which is collected in an observer perspective mode by the second attention detection module. The second attention detection module monitors the first host person, and upon detecting an attention clue of the first host person, signals to the first attention detection monitor information concerning the first host person, which is analyzed by the self perspective analyzer of the first attention detection module 1300.

Conversely, first attention detection module 1300 monitors the second person, and upon detecting an attention clue of the second person signals to the second attention detection monitor 1301 attention clues concerning the second person. The second attention detection monitor 1301 incorporates the information received from the first attention detection monitor, in a self perspective analysis mode of the second attention detection monitor, in which the second detection monitor analyses attention clues of the second host person in order to determine whether an image signal should be generated for capturing an image using the second persons image capture device.

Claims:

1. An attention detection system comprising:

at least one sensor device capable of generating signals of a host person from a self-perspective and relating to attention clue signals; and

at least one sensor device capable of generating signals of a host person from an observer perspective and relating to said attention clue signals;

a portable attention detection module capable of receiving the self perspective and observer perspective attention clue signals and which is capable of determining a situation of raised attention of said host wearer from said self perspective attention clues, and said received observer perspective attention clues.

2. The attention detection system as claimed in claim 1, further comprising:

an image capture device for capturing an image from a self perspective of said host wearer, in response to a determined situation of raised attention.

3. The system as claimed in any one of the preceding claims, wherein said at least one sensor device for generating signals from a host perspective are adapted for wearing by said host person.

4. The system as claimed in any one of the preceding claims, wherein said at least one sensor device for generating signals from an observer perspective is adapted to be worn by a further person.

5. The system as claimed in any one of claims 1 to 3, wherein said at least one sensor device for generating signals from an observer perspective is adapted to be placed in an environment which said host person may occupy.

6. The system as claimed in any one of the preceding claims, further comprising a people-observing device, which is configured for communicating with said attention detection module.

7. The system as claimed in claim 6, comprising a plurality of people-observing devices, which are capable of:

communicating with said attention detection module; and

communicating with each other.

8. The system as claimed in claim 6 or 7, comprising at least one camera device.

9. The system as claimed in any one of the preceding claims comprising first and second people-observing devices adapted for using beacons to locate and detect each other.

10. The system as claimed in any one of the preceding claims which is integrated into a host wearable device.

11. The system as claimed in any one of the preceding claims, comprising a people-observing device capable of communicating with said attention detection module, wherein said people-observing device is configurable for cooperating with at least on other people-observing device for communicating information with said at least one other people- observing device.

12 The system as claimed in any one of the preceding claims, comprising a people-observing device capable of communicating with said attention detection module, wherein said people-observing device is configurable for recognizing ate least one other people-observing device to form a group of people-observing devices which recognize each other.

13. The system as claimed in claim 12, wherein said people-observing device is configurable for being set to communicate or not communicate with at least one other people-observing devices based on an analysis of contextual information relating to a host person.

14. The system as claimed in claim 1, comprising a people-observing device configurable for being set to communicate or not communicate with at least one other people-observing devices based on an analysis of a type of attention clue detected.

15. The system as claimed in claim 1, comprising at least one people observing-device configurable for being set to communicate or not communicate with at least one said attention detection module depending upon a type of attention clue detected.

16. The system as claimed in claim 1, comprising a digital camera device capable of capturing a 2-dimensional digital image.

17. The system as claimed in any one of the preceding claims, wherein the sensor device detects a facial expression of a said person.

18. The system as claimed in any one of the preceding claims, wherein the sensor device detects an eye direction of a said person.

19. The system as claimed in any one of the preceding claims, wherein the sensor device detects an attitude of movement of a said person.

20. The system as claimed in any one of the preceding claims, comprising a means for detecting a body posture of a said person.

21. The system as claimed in any one of the preceding claims, comprising means for detecting a context of an environment containing a said person.

22. The system as claimed in any one of the preceding claims detects a voice utterance of a said person.

23. A method of capturing images using at least one camera device, said method comprising:

detecting an attention clue exhibited by at least one human person, from a perspective of a host person carrying said at least one camera device, said attention clue indicating that said persons attention is drawn by a subject; and

detecting an attention clue of said host person from an observer perspective external of said host wearer;

activating said at least one camera device for capture of an image of said subject, in response to detection of said self perspective attention clue and said observer perspective attention clue.

24. The method as claimed in claim in claim 23, wherein a said step of detecting an attention clue comprises detecting a facial expression of said at least one person.

25. The method as claimed in claim in claim 23, wherein a said step of detecting an attention clue comprises detecting an eye direction of said at least one person.

26. The method as claimed in any of claims 23 to 25, wherein a said step of detecting an attention clue comprises detecting an attitude of movement of said at least one person.

27. The method as claimed in claim in any one of claims 23 to 26, wherein said step of detecting an attention clue comprises detecting a body posture of said at least one person.

28. The method as claimed in claim in any one of claims 23 to 27, wherein said step of detecting an attention clue comprises detecting a voice utterance of said at least one person.

29. The method as claimed in any one of claims 23 to 28, wherein detecting an attention clue comprises:

capturing a two dimensional image; and

applying an image processing to said two dimensional image to detect an attention clue selected from the set:

a facial expression;

an eye direction;

a body movement;

a body posture.

30. A method of automatically capturing an image, said method comprising;

detecting at least one attention signal in response to a detectable body parameter of at least one human person;

analyzing said at least one attention signal to determine an interest level of said at least one human person; and

activating capture of a said image, in response to said interest level.

31. The method as claimed in claim 30, comprising;

determining a situational saliency of a scene, by analyzing said at least one attention signal.

32. The method as claimed in claim 31 or 32, wherein said analysis is performed in a mode of self perspective of a said person.

33. A method as claimed in claim 31 or 32, wherein said analysis is performed in a mode of an observer perspective of said at least one person.

34. An image capture device comprising:

an image detector device capable of capturing a two dimensional image;

an attention detection component for determining an attention signal of a person from a self perspective;

a transponder device for receiving activation signals from a remote source;

wherein said attention detection component is configured for identifying said activation signals, and activating capture of an image in response to a said self perspective activation signal and said received activation signal;

35. A people observing device for observing at least one person, said people- observing device comprising:

an interface for interfacing with at least one sensor device; and

means for receiving sensor signals, said sensor signals representing aspects of a persons body language, which are observed from a position external of said person; and

an analyzer for determining from said sensor signal signals at least one attention clue of said observer person; and a transmitter for transmitting attention signals.

36. The people monitoring device as claimed in claim 35, further comprising:

a transponder device capable of transmitting said sensor signals.

37. The people monitoring device as claimed in claim 35 or 36, further comprising:

an image capture device for capturing two dimensional image frames.

38. An attention detection component for determining a level of attention of at least one person, said component comprising:

analyzer means for analyzing at least one attention clue signal, and determining from said attention clue signal, a level of interest of said at least one person.

39. The attention detection component as claimed in claim 38, operable for:

analyzing said attention clues in a self perspective mode, in which said attention clues relate to a single host person.

40. The attention detection component as claimed in claim 38, operable in an observer perspective mode, in which said attention clues represent signals describing behavior of a person observed from a remote location.

41. The attention detection component as claimed in claim 38, comprising a transponder device for receiving said attention clue signals from a remote sender device.

42. Computer program product comprising:

an analysis component for analyzing a plurality of sensor signals representing attention clues collected from a self perspective of a person, and attention clues collected from an observed perspective of said person, and determining from said sensor signals, a behavioral mode of a person; and

a component for generating an image capture trigger signal for triggering an image capture device to capture a two-dimensional image data, in response to a said sensed behavioral mode of said person.

43 An attention detection system comprising:

a portable attention detection module capable of receiving attention clues generated from a self perspective of a host wearer of said attention detection module;

a people-observing device capable of observing said host wearer from an observer perspective external of said host wearer and determining attention clues of said host wearer from said observer perspective externally of said host wearer;

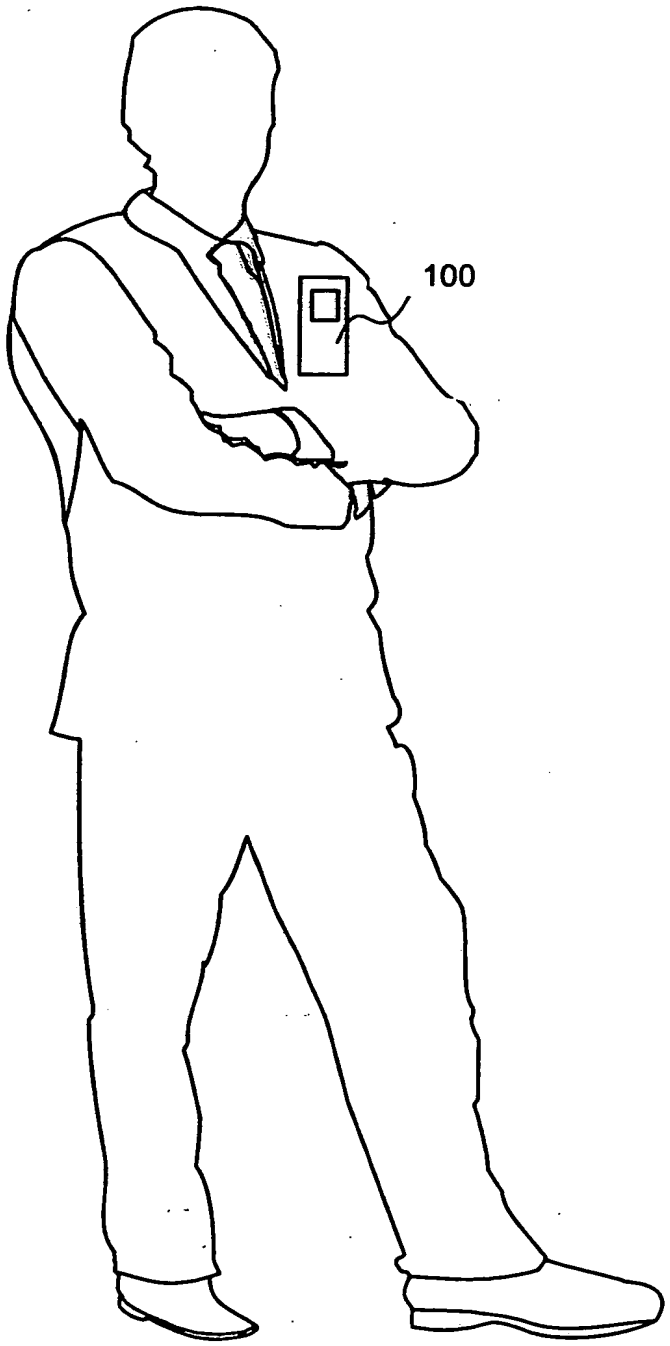
wherein said attention detection module is capable of determining a situation of raised attention of said host wearer from said self perspective attention clues, and said received observer perspective attention clues.

Abstract

ATTENTION DETECTION

An attention detection system comprises: a portable attention detection module capable of receiving attention clues of a host person, said attention clues generated from a self perspective of said host person, and receiving attention clues of said host person generated from an observer perspective; at least one sensor device capable of generating signals relating to said attention clue signals of said self perspective; and at least one sensor device capable of generating signals relating to said attention clue signals of said observer perspective.; wherein said attention detection module is capable of determining a situation of raised attention of said host wearer from said self perspective attention clues, and said received observer perspective attention clues.

Fig. 3



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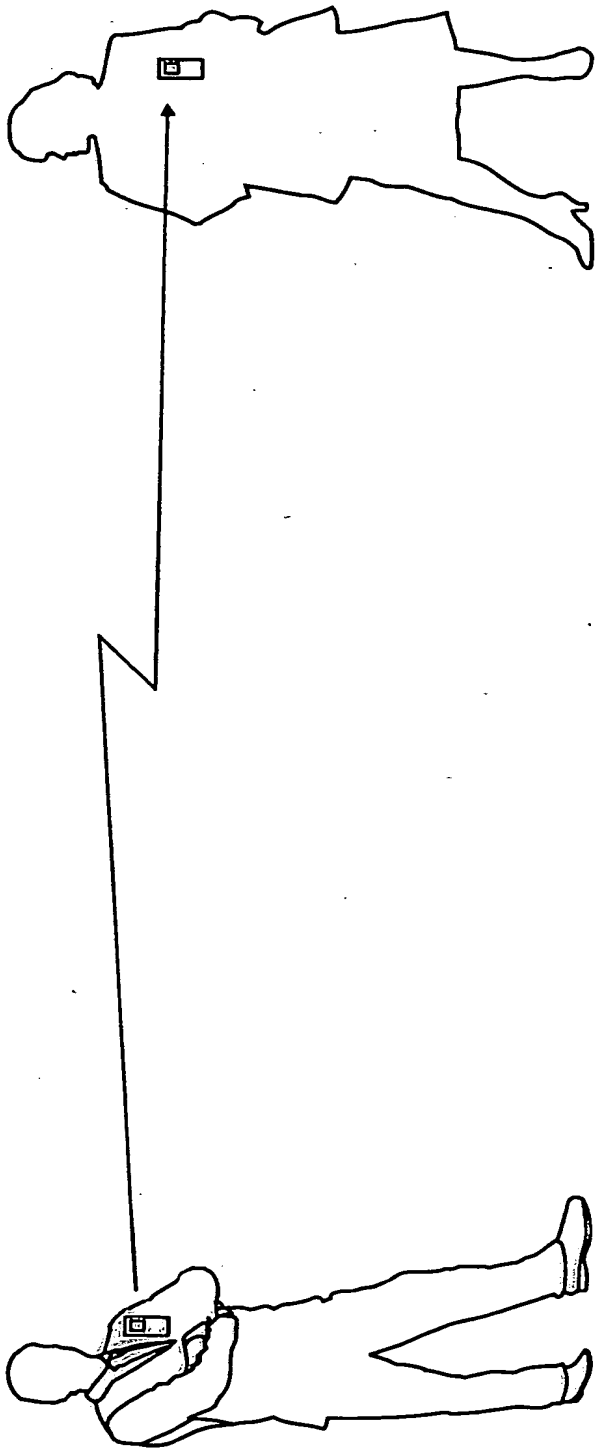
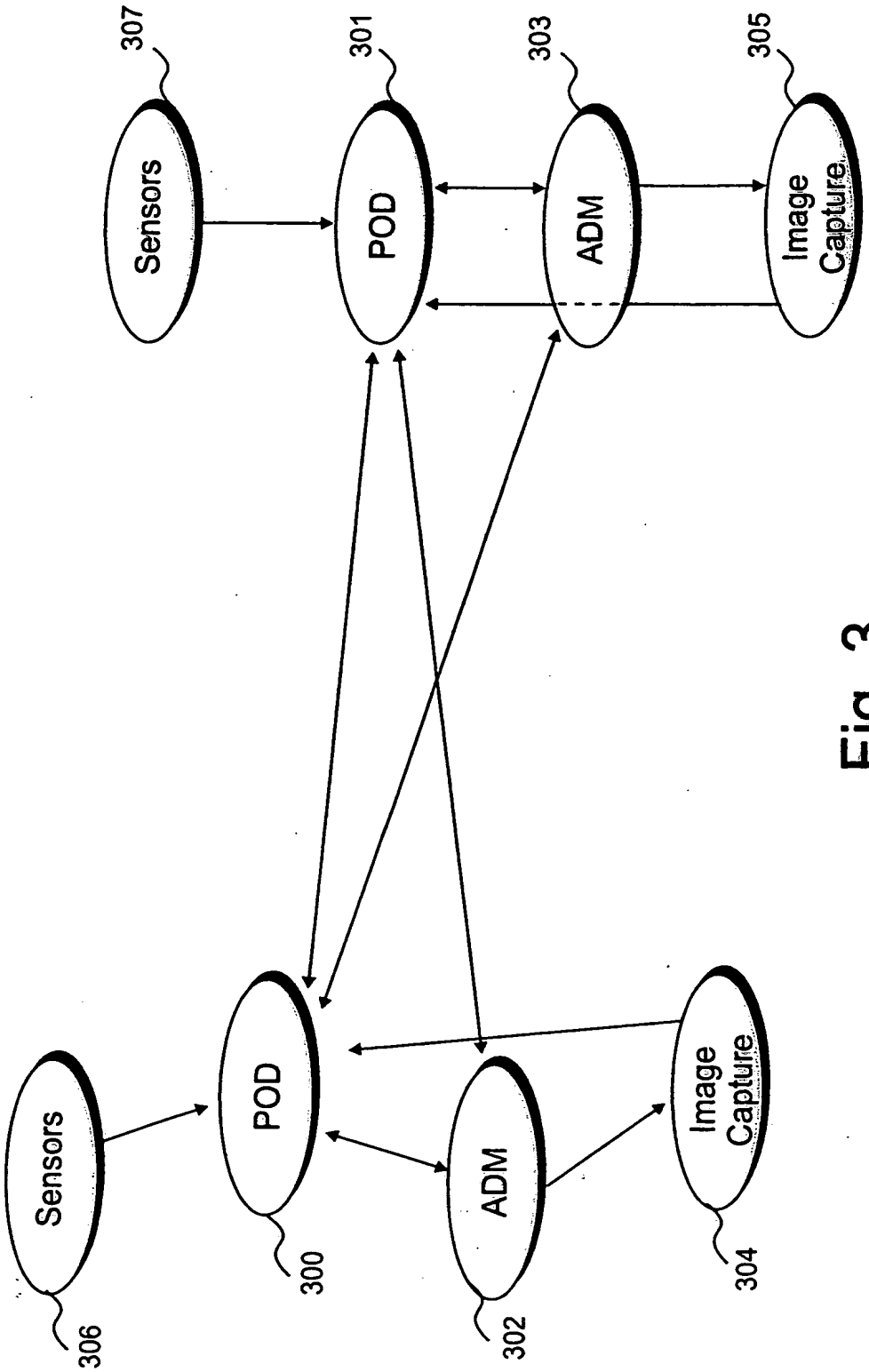


Fig. 2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POD
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ADM
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Image Capture
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Sensors
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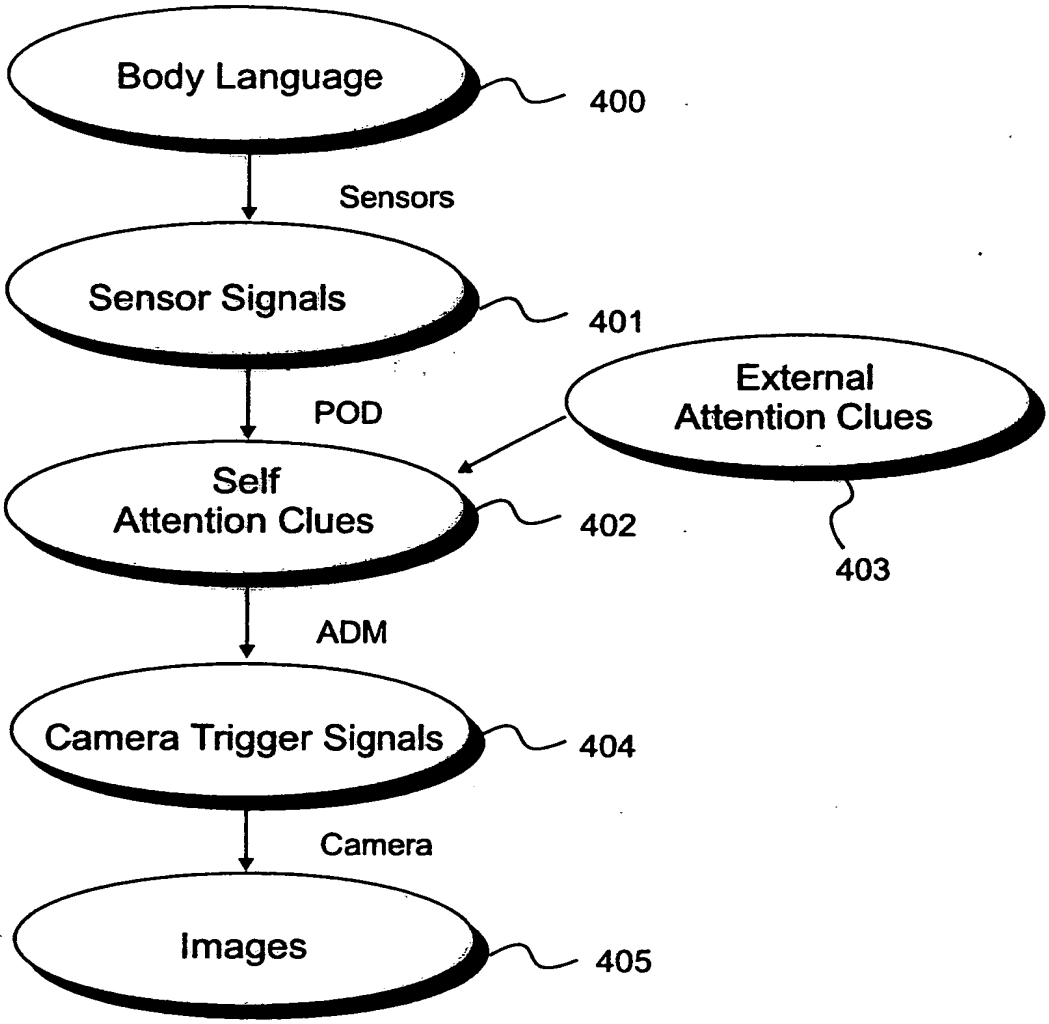
Image Capture
304

Fig. 3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Sensor Signals
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Attention Clues
Self
Attention Clues
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403
ADM
Camera Trigger Signals
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Camera
Images
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Fig. 4

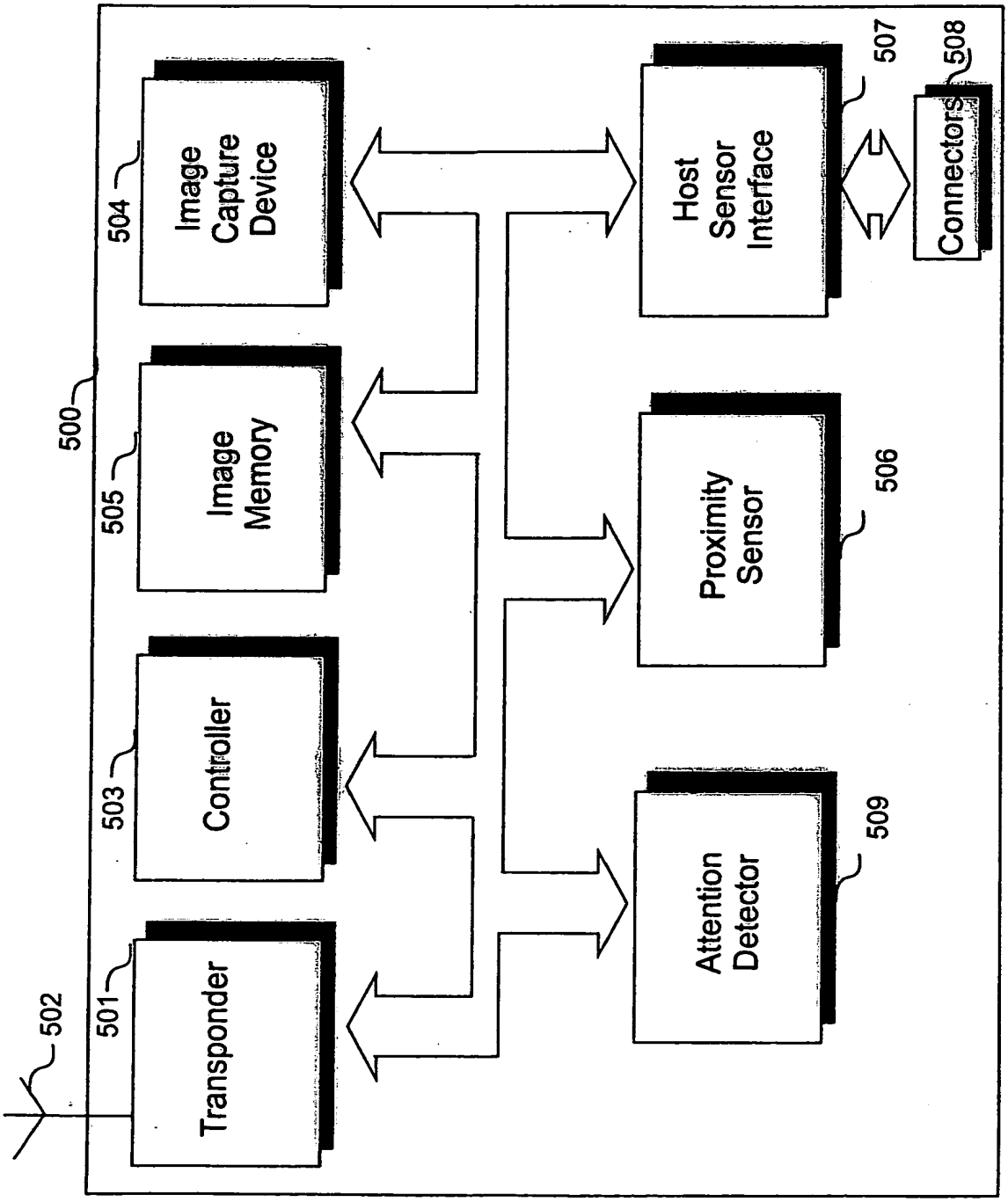
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Image Memory
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Controller
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Transponder
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Host Sensor Interface
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Connectors
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Proximity Sensor
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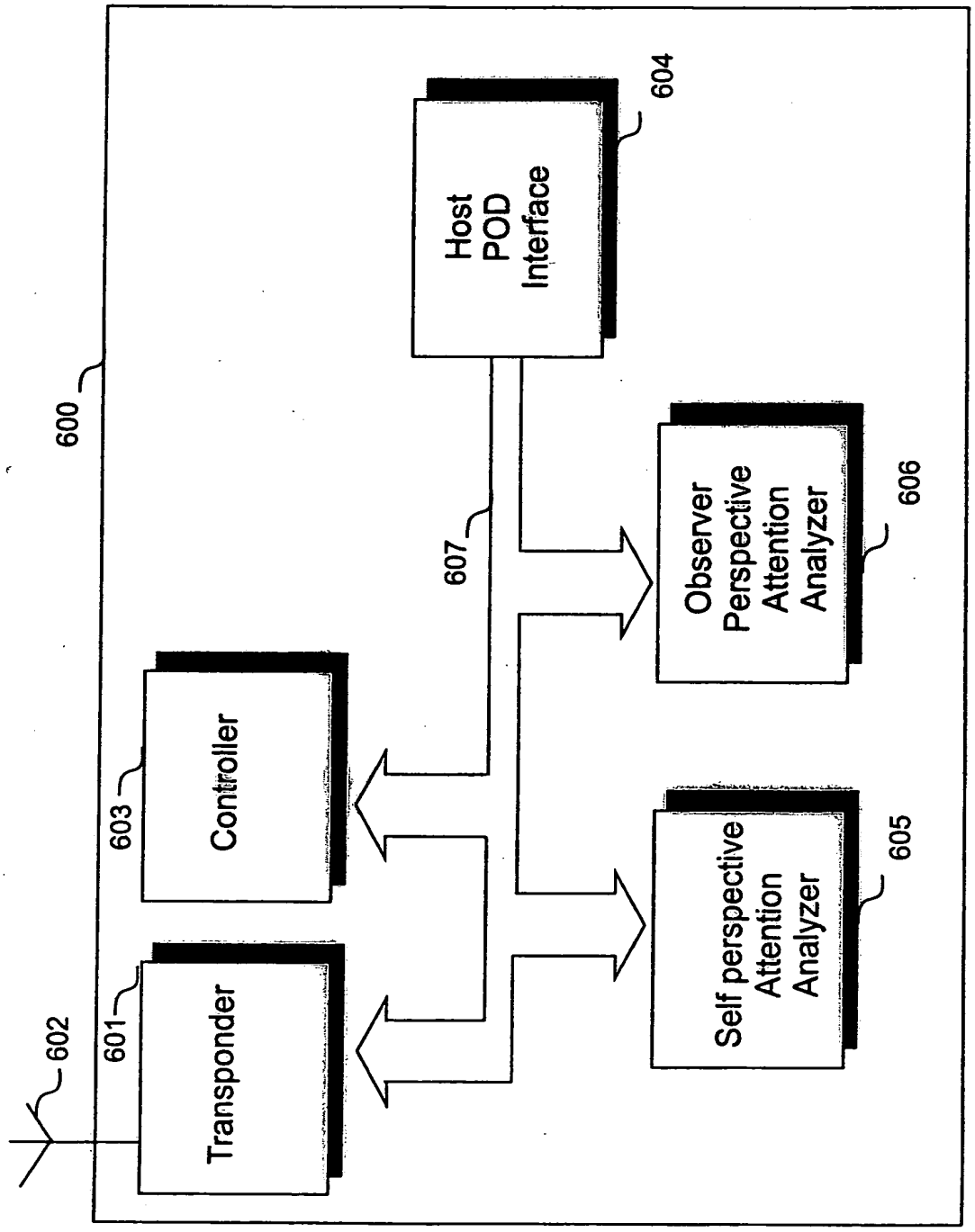
Attention Detector
509

Fig. 5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Transponder
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Controller
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Observer
Perspective
Attention
Analyzer
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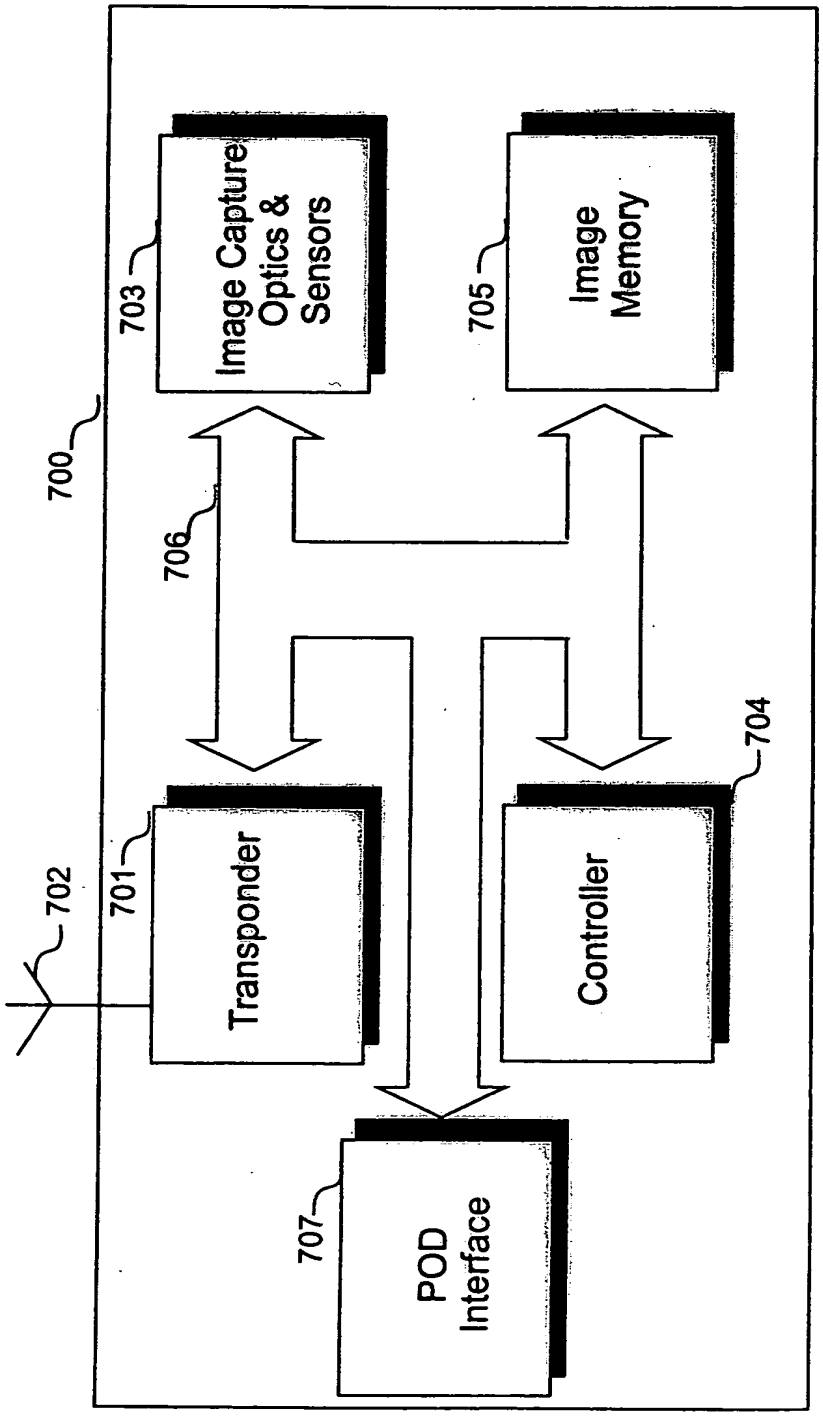
Self perspective
Attention
Analyzer

Fig. 6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Transponder
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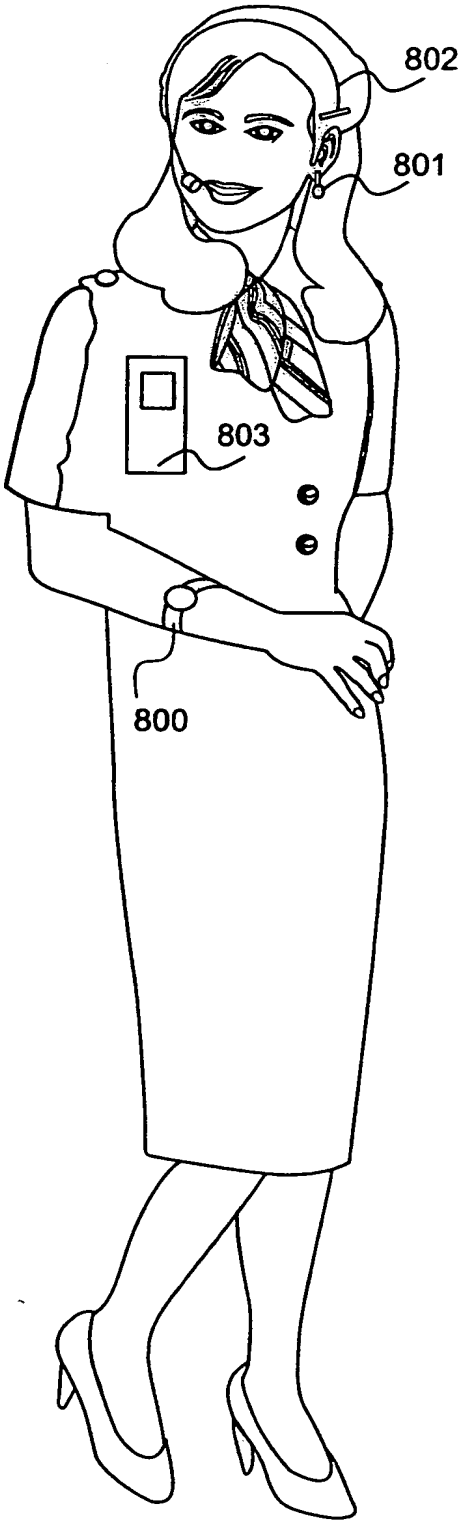
Controller
707
POD Interface

Fig. 7



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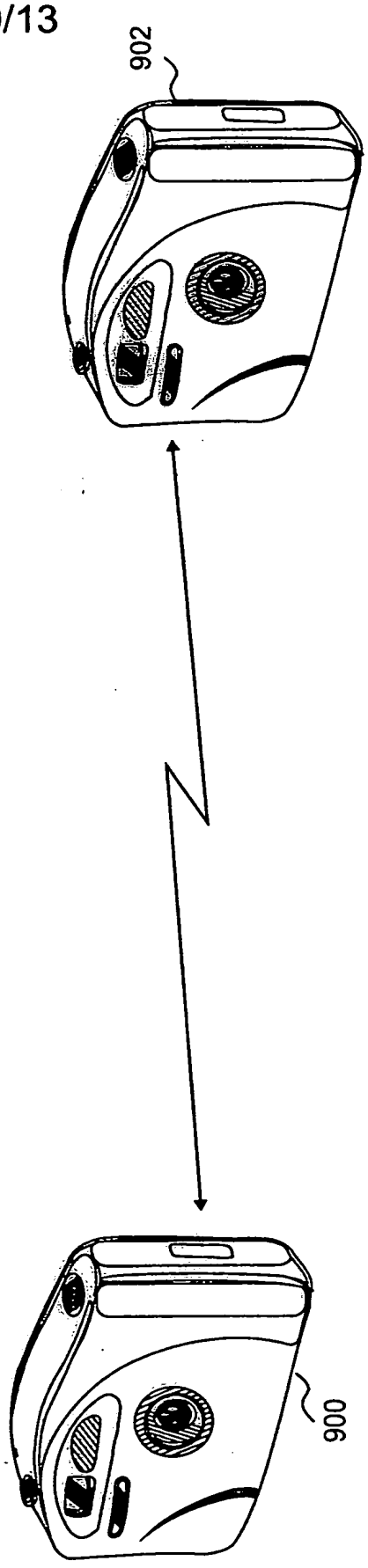


Fig. 9

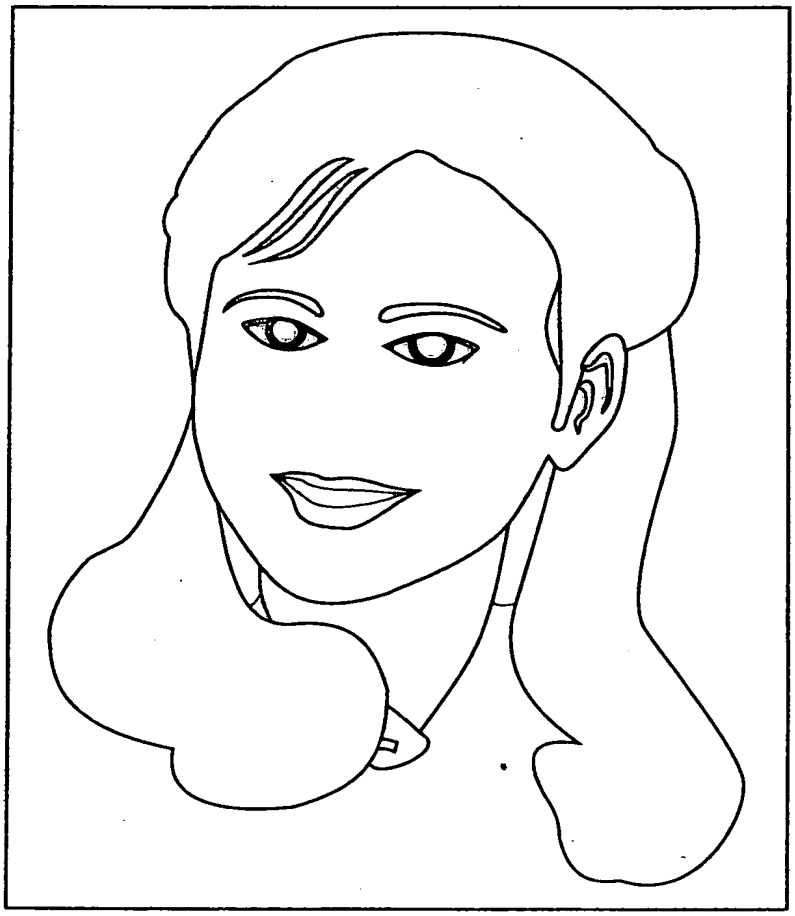
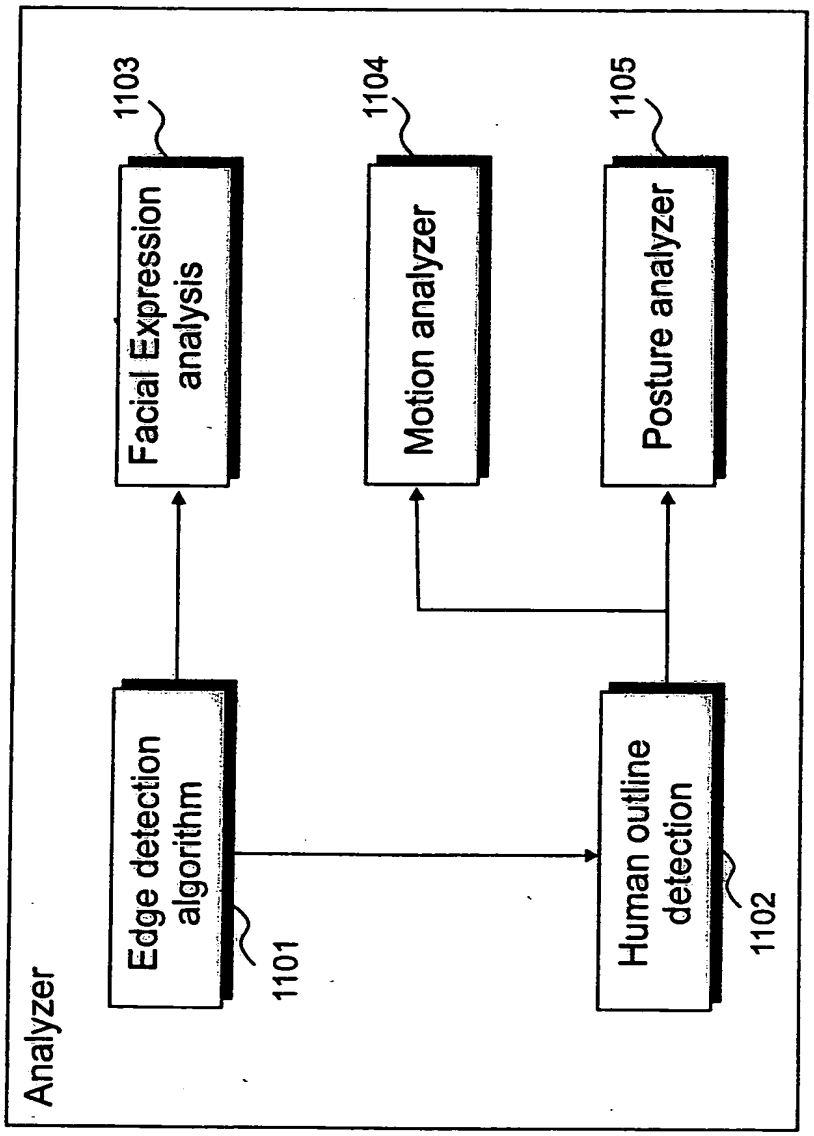


Fig. 10


Analyzer
Edge detection algorithm
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Facial Expression analysis
1103
Human outline detection
1102
Motion analyzer
1104
Posture analyzer
1105

Fig. 11

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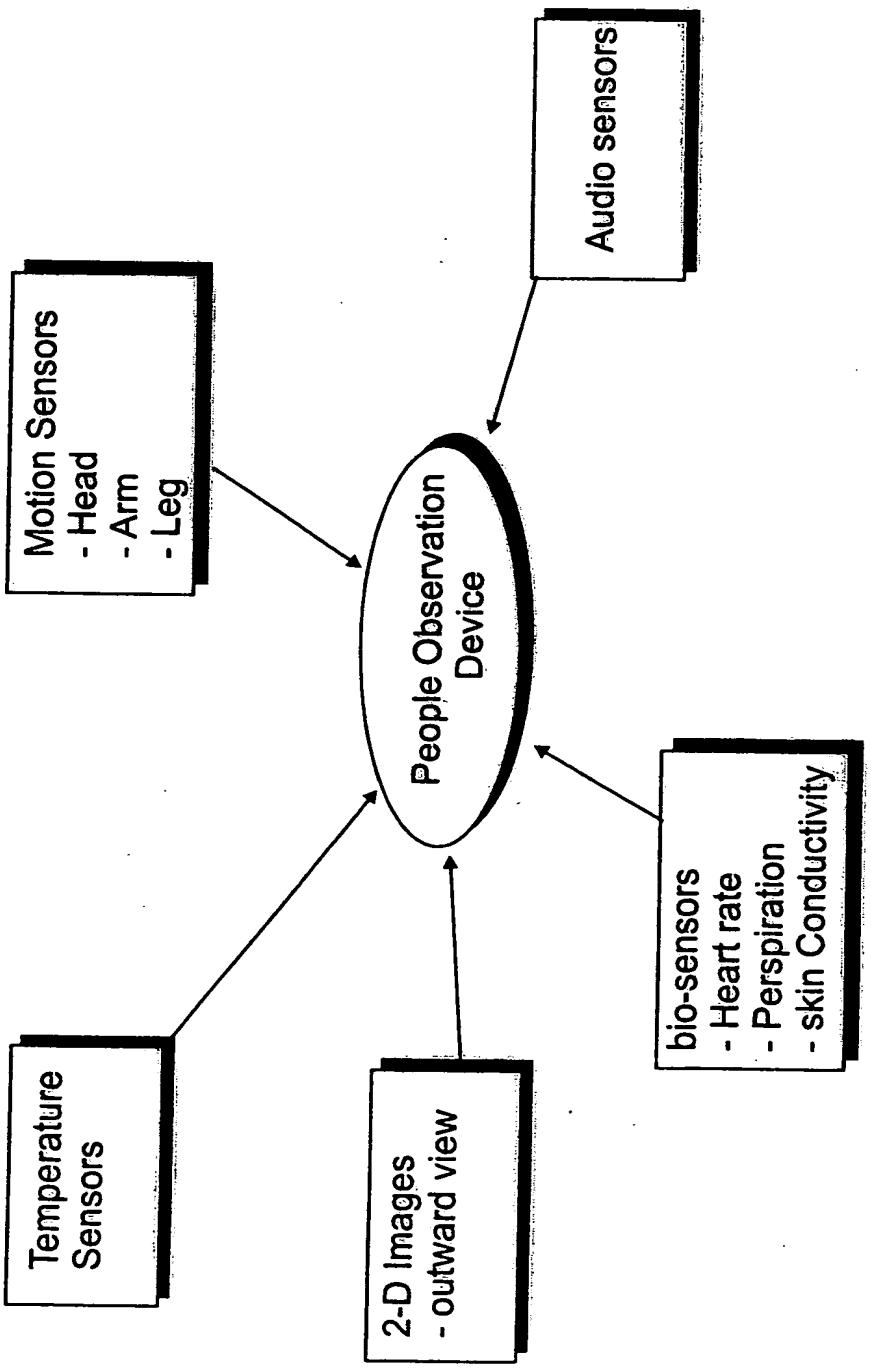
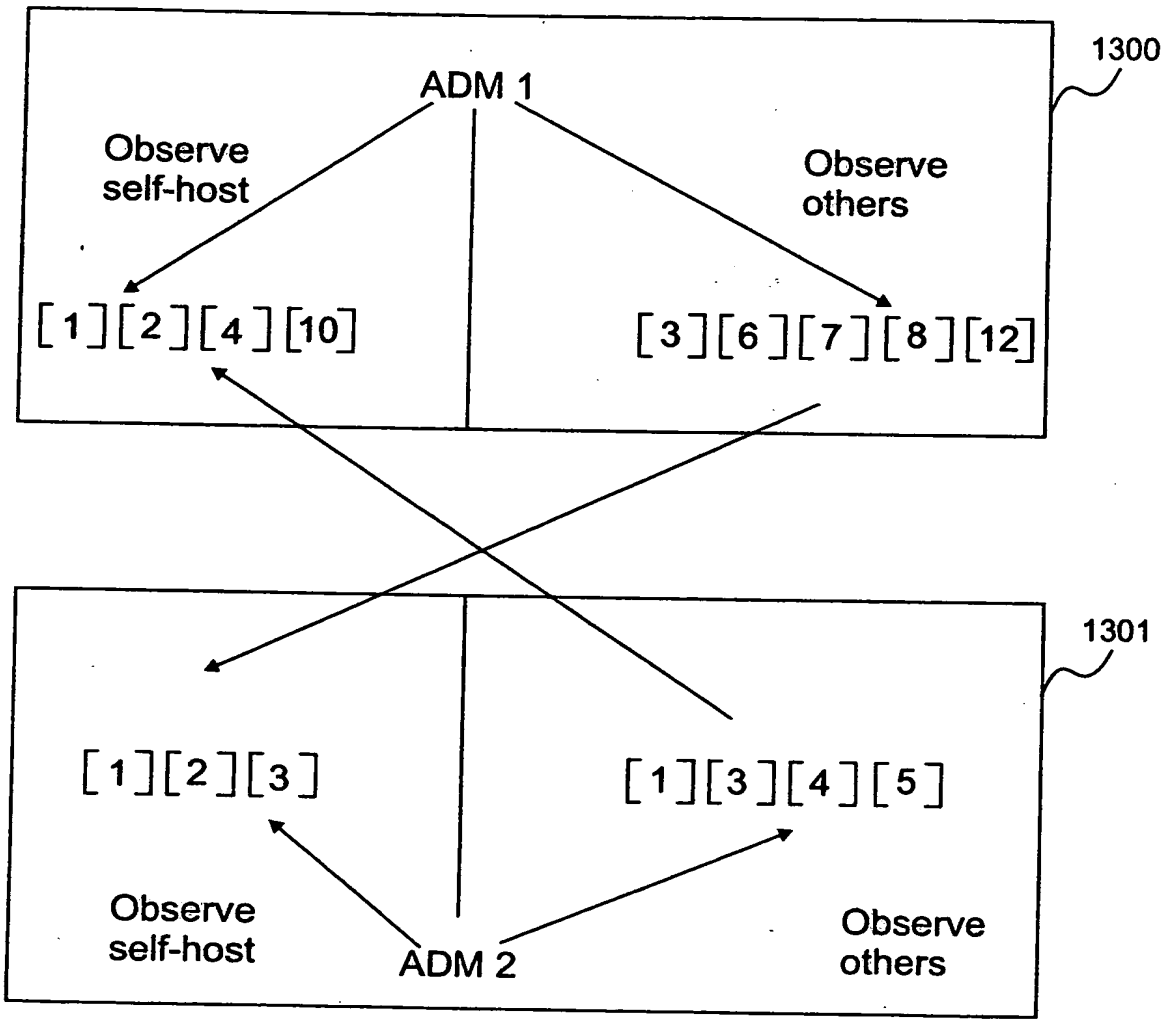

Motion Sensors
- Head
- Arm
- Leg
Audio sensors
People Observation Device
Temperature Sensors
2-D Images
- outward view
bio-sensors
- Heart rate
- Perspiration
- skin Conductivity

Fig. 12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Observe others

Fig. 13